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09/694,090	10/19/2000	Philippe Guyot-Sionnest	7814/43	7386

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BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60611

EXAMINER
UHLIR, NIKOLAS J

ART UNIT	PAPER NUMBER
1773	11

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Please find below and/or attached an Office communication concerning this application or proceeding.

CK 11

Office Action Summary	Application No. 09/694,090	Applicant(s) GUYOT-SIONNEST ET AL.	
	Examiner Nikolas J. Uhlir	Art Unit 1773	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 October 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-42* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-38, 40* is/are rejected.

7)☒ Claim(s) *39,41 and 42* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

1. This action is in response to the amendment/request for reconsideration filed 10/15/02. After careful consideration of both the applicant's arguments and the prior art of record, the rejection dated 6/13/02 is hereby withdrawn. In particular, applicant's arguments related to the difference between carrier doping (electrons, holes) and elemental doping persuaded the examiner to reconsider the prior rejection. Accordingly, a new office action follows below.

2. It is of particular note that the examiner is interpreting the Alivisatos et al. (US5537000) differently then was presented in the first office action. The examiner feels that Alivisatos et al. reads on many of the applicants claims, as will be discussed below.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims 34, 35, and 36 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. In the instant case, claims 34 and 35 require the semiconductor nanocrystals described in claims 1 and 5 respectively to comprise sodium. There is no support in the claims or specification as originally filed for this limitation. While the applicant has provided support for doping a semiconductor

nanocrystals such as CdS, CdSe, or ZnS with an electron by contacting the nanocrystals with a reducing agent that comprises sodium, there is no support in the specification that this process results in semiconductor nanocrystals that contain sodium (as is required by claims 34 and 35). Thus, the limitations of claims 34 and 35 are new matter. Correction is required.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 1-2, 4-5, 7, 9-13, 15-16, 20-24, 27-29, 31-32 and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Alivisatos et al. (US5537000).

7. Regarding the limitations of claim 1, wherein the applicant requires a semiconductor nanocrystal that is doped with a carrier selected from the group consisting of an electron and a hole.

8. Alivisatos et al. teaches an electroluminescent device that comprises a hole injection electrode (10), a hole transport layer (20), a electron transport layer (30), and an electron injection layer (40) (Figure 5, and column 8, lines 5-30). The electron transport layer is made of semiconductor nanocrystals (column 6, lines 4-12). As a voltage is applied to the electroluminescent device, the recombination zone (position where electrons and holes reunite to form exitons)

can be shifted from the electron transport layer to the hole transport layer, with a corresponding change in the wavelength of light that is emitted (column 8, lines 5-30)

9. Therefore it would have been obvious to one with ordinary skill in the art to change the voltage applied to the electroluminescent devive taught by Alivisatos et al. in order to change the position of the recombination zone.

10. It is the examiners position that the limitations of claim 1 are met when the recombination zone in the device taught by Alivisatos et al. is located in the hole transport layer. In this state, the electron transport layer will contain excess electrons, and thus will be n-doped during the period in which the current/voltage is applied. This appears to be very similar to the electrochemical doping method discussed by the applicant on pages 6 and 7 of the instant specification.

11. Regarding the limitations of claim 2, wherein the applicant requires the nanocrystal to be n-doped (contain extra electrons). This limitation is met as set forth above for claim 1.

12. Regarding the limitations of claims 4 and 5, wherein the applicant requires the nanocrystal to be a II-IV semiconductor (claim 4), specifically selected from the group consisting of CdS, CdSe, and ZnO. Alivisatos et al. teaches that suitable semiconductor nanocrystals for the electron transport layer include those of CdS and CdSe, as well as other II-VI and III-V semiconductors.

13. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize CdS, or CdSe as the semiconductor nanocrystals in Alivisatos et al.

14. Applicant is respectfully reminded that substitution of equivalents requires no express motivation as long as the prior art recognizes the equivalency. *In Re Fount* 213 USPQ 532 (CCPA 1982); *In Re Siebentritt* 152 USPQ 618 (CCPA 1967); *Grover Tank & Mfg. Co. Inc V. Linde Air Products Co.* 85 USPQ 328 (USSC 1950).

15. Regarding the limitations of claim 7, wherein the applicant requires a film comprising a plurality of the particles according to claim 1. This limitation is met as set forth above for claim 1.

16. Regarding the limitations of claim 9, wherein the applicant requires a film comprising a plurality of the particles according to claim 4. This limitation is met as set forth above for claim 4.

17. Regarding the limitations of claim 10, wherein the applicant requires a method of making a particle, comprising adding at least one carrier to a semiconductor nanocrystal, to form a doped semiconductor nanocrystal, wherein the carrier is selected from the group consisting of an electron and a hole. These limitations are met as set forth above for claim 1, as Alivisatos et al. teaches applying a voltage to an electroluminescent device such that the recombination zone moves from the electron transport layer (composed of Semiconductor nanocrystals) to the hole transport layer. Although this process is not expressly stated to add an electron or a hole to the nanocrystals, as shown above for claim 1, this process will result in the nanocrystals containing excess electrons, and thus meets the requirements of claim 10.

18. Regarding the limitations of claim 11, wherein the applicant requires the adding step of claim 10 to comprise contacting the nanocrystals with an oxidizing or reducing agent. This limitation is met as set forth above for claim 10. The examiner interprets "oxidizing or reducing agent" to mean anything that results in the oxidation or reduction of the semiconductor nanocrystals. Thus, the voltage/current taught by Alivisatos et al. reads on these limitations, as it effectively "reduces" the nanocrystals in the electron transport layer by providing the layer with extra electrons. Thus, the limitations of claim 11 are met.

19. Regarding the limitations of claim 12, wherein the applicant requires the adding step of claim 10 to comprise oxidizing or reducing electrochemically. This limitation is met as set forth above for claim 11.

20. Regarding the limitations of claim 13, wherein the applicant requires the carrier in the method of claim 10 to be selected from the group consisting of an electron and a hole. This limitation is met as set forth above for claim 10, as the method utilized by Alivisatos et al. will result in the electron transport layer containing more electrons.

21. Regarding the limitations of claims 15 and 16, wherein the applicant requires the method of claim 10 to utilize a II-VI semiconductor (claim 15), specifically selected from the group consisting of CdS, CdSe, and ZnO (claim 16). These limitations are met as set forth above for claims 10, 4, and 5.

22. Regarding the limitations of claim 20, wherein the applicant requires a film containing semiconductor nanocrystals made by the method of claim 11. This limitation is met as set forth above for claims 11 and 7.

23. Regarding the limitations of claims 21-24, and 27 wherein the applicant requires a product made by the methods of claims 10, 11, 12, 13, and 20 respectively. As no further limitations related to the product are required in claims 21-24 and 27, these limitations are met as set forth above for claims 10-13 and 20.

24. Regarding the limitations of claim 28 wherein the applicant requires a display comprising the particles of claim 1. The examiner takes the position that the electroluminescent device taught by Alivisatos et al. is equivalent to applicants claimed "display." Thus, the limitations of claim 28 are met.

25. Regarding the limitations of claim 29, wherein the applicant requires an opto-electronic device comprising the particles of claim 1. The examiner takes the position that because the device of Alivisatos et al. emits light at a wavelength that is controlled by the voltage applied, the device of Alivisatos et al. meets the requirement of an optoelectronic device.

26. Regarding the limitations of claim 31, wherein the applicant requires a method of making an object appear warmer or cooler to an IR detector, comprising coating the object with a plurality of the particles of claim 1. The examiner takes the position that the IR properties of semiconductor nanocrystals are material properties. Thus, because the materials used by Alivisatos et al. match the materials utilized by the applicant, and because the Alivisatos et al. meets all of the method requirements of claim 31 (coating semiconductor nanocrystals on a substrate), these limitations are met.

27. Regarding the limitations of claim 32, wherein the applicant requires an n-p junction comprising a plurality of the particles of claim 1. Alivisatos et al. teaches that the hole-processing layer is formed form either a conducting polymer or a p-doped semiconductor (column 25-28). Therefore it would have been obvious to one with ordinary skill in the art at the time the invention was made to utilize a p-doped semiconductor as the hole transport layer of Alivisatos et al., as they are taught to be equivalent for this purpose. Thus, the examiner takes the position that when a p-type semiconductor is utilized as the hole transport layer and a voltage is applied such that the recombination zone falls in the hole transport layer, the requirement of an n-p junction comprising the particles of claim 1 is met.

28. Regarding the limitations of claim 40, wherein the applicant requires the use of a charge shuttle in the method according to claim 11. The examiners position regarding claim 11 is stated above. With respect to claim 40, applicants have described a "charge shuttle" on page 6 of the instant specification as "something that improves the rate at which doping takes place." Alivisatos et al. teaches that the electron injection layer or electrode should comprise a metal or n-doped semiconductor layer that is capable of injecting electrons into the electron transport layer (column 7, lines 45-50). It is the examiners position that the electron injection layer of Alivisatos et al. meets the requirement of a charge shuttle, in that the electron injection layer promotes the transfer of electrons into the electron transport layer.

29. Claims 1-5, 7, 9-16, 20-22, 27-29, 31-32 and 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. (US6057561) in view of White et al. (US6342313).

30. Regarding the limitations of claim 1, wherein the applicant requires a semiconductor nanocrystal that is doped with a carrier selected from the group consisting of an electron and a hole.

31. Kawasaki et al. teaches an optical semiconductor element that comprises an n-type MgZnO layer (2), an n-type electrode (3), an N-type ZnO layer (4), an undoped ZnO layer (5), a p-type ZnO layer (6), a p-type MgZnO layer (7), and a p-type electrode (8) (Column 13, lines 19-29 and figure 31). The ZnO films are preferably thin films of hexagonal ZnO nanocrystals formed by molecular beam epitaxy (MBE) (column 2, lines 15-20). The examiner takes the position that the nanocrystals of Kawasaki et al. are equivalent to applicants claimed nanocrystals.

32. Therefore it would have been obvious to one with ordinary skill in the art at the time the invention was made to utilize ZnO nanocrystals as the ZnO layers in the optical semiconductor device of Kawasaki et al.

33. Substitution of equivalents requires no express motivation as long as the prior art recognizes the equivalency. *In Re Fount* 213 USPQ 532 (CCPA 1982); *In Re Siebentritt* 152 USPQ 618 (CCPA 1967); *Grover Tank & Mfg. Co. Inc V. Linde Air Products Co.* 85 USPQ 328 (USSC 1950)

34. Further, as shown by figure 30, the spectrum of a superlattice of the ZnO nanocrystals exhibits a emission peak that shifts as the thickness of the film is

varied, which occurs as a result of quantum confinement of carriers (column 13, lines 5-15). Thus, the limitations of claim 1 are met when ZnO nanocrystals are utilized.

35. Regarding the limitations of claim 2, wherein the applicant requires the nanocrystal to be n-doped (contain extra electrons). This limitation is met as set forth above for claim 1, as Kawasaki et al. teaches the use of ZnO nanocrystalline films which are n-doped.

36. Regarding the limitations of claim 3, wherein the applicant requires the nanocrystal to be p-doped (contain extra holes). This limitation is met as set forth above for claim 1, as Kawasaki et al teaches the use of p-doped ZnO nanocrystalline films.

37. Regarding the limitations of claims 4-5, wherein the applicant requires the nanocrystal to be a II-VI semiconductor, specifically selected from the group consisting of CdS, CdSe, and ZnO. These limitations are met, as Kawasaki et al teaches the use of p and n-doped ZnO nanocrystals.

38. Regarding the limitations of claims 7 and 9, wherein the applicant requires a film comprising a plurality of the particles of claim 1 and 4 respectively. These limitations are met as set forth above for claims 1 and 4.

39. Regarding the limitations of claim 10, Kawasaki et al. does not teach a method for making a particle comprising adding at least one carrier selected from a the group consisting of an electron and a hole to a semiconductor nanocrystal to form a doped semiconductor nanocrystal.

40. However, White et al. teaches a method for manufacturing p-type ZnO. This method comprises adding a p-type dopant to undoped ZnO. Suitable p-type dopants include Li, Na, K, Rb, and Cs. By adding a "p-type" dopant to the ZnO, holes are added to the film (column 4, line 40-column 5, line 11). Further, White et al. teaches that n-type ZnO can be made by incorporating a n-type dopant such as aluminum into the semiconductor (column 7, lines 33-35). This adding is done by either contacting the semiconductor film with a substrate and annealing the composite to diffuse the dopant into the ZnO film, or by pulsed layer depositing ZnO and the dopant simultaneously in a chamber (column 10, example 1 and column 7, lines 33-55).

41. Therefore it would have been obvious to utilize one of the methods taught by White et al. to form the p-doped or n-doped ZnO layers utilized in Kawasaki et al.

42. One would have been motivated to do so due to the fact that Kawasaki et al. utilizes p and n-doped ZnO layers, and the fact that the processes utilized by White et al. are known to produce p and n-doped ZnO.

43. Thus, the limitations of claim 10 are met.

44. Regarding the limitations of claim 11, wherein the applicant requires the adding step to comprise contacting the semiconductor nanocrystal with an oxidizing or reducing agent. The examiner takes the position that the method taught by White et al. meets this requirement, as incorporating a p or n-type dopant into a semiconductor effectively oxidizes/reduces the semiconductor

compound by providing extra holes/electrons. Thus, the limitations of claim 11 are met.

45. Regarding the limitations of claim 12, wherein the applicant requires the adding step to be done electrochemically, this limitation is met as set forth above for claim 11, as oxidation and reduction are electrochemical reactions.

46. Regarding the limitations of claim 13, wherein the applicant requires the method of claim 10, wherein the carrier is at least one electron. This limitation is met as set forth above for claim 10, as White et al. teaches adding aluminum to ZnO to form an n-type semiconductor.

47. Regarding the limitations of claim 14, wherein the applicant requires the method of claim 10, wherein the carrier is at least one hole. This limitation is met as set forth above for claim 10, as White et al. teaches adding a p-type dopant such as Na to ZnO to form a p-type semiconductor.

48. Regarding the limitations of claims 15 and 16, wherein the applicant requires the nanocrystal to be a II-VI semiconductor (claim 15) selected from the group consisting of ZnO, CdS, and CdSe. These limitations are met as set forth above for claim 10, as Kawasaki et al. as modified by White et al. teaches the use of ZnO nanocrystals.

49. Regarding the limitations of claim 20, wherein the applicant requires the method of claim 11, wherein the semiconductor nanocrystal is in a film comprising a plurality of semiconductor nanocrystals. This limitation is emt as set forth above for claim 10.

50. Regarding the limitations of claims 21-24, and 27, wherein the applicant requires a product produced by the methods of claims 10-13 and 20. As no limitations regarding the product are presented in these claims, these limitations are met as recited above for claims 10-13 and 20.

51. Regarding the limitations of claims 28, wherein the applicant requires a display comprising a plurality of the particles of claim 1. Kawasaki et al. teaches the use of p and n-type ZnO nanocrystals in the formation of a display (column 9, lines 18-27). Thus, this limitation is met.

52. Regarding the limitations of claim 29, wherein the applicant requires an opto-electronic device comprising a plurality of the particles of claim 1. These limitations are met as set forth above for claim 28. The display taught by Kawasaki et al. is equivalent to the applicant required opto-electronic device.

53. Regarding the limitations of claim 31, wherein the applicant requires a method of making an object appear warmer or cooler to an IR detector, comprising coating the object with a plurality of the particles of claim 1. The examiner takes the position that the IR properties of semiconductor nanocrystals are material properties. Thus, because the materials used by Kawasaki et al. as modified by White et al. et al. match the materials utilized by the applicant, and because the Kawasaki et al. as modified by White et al. meets all of the method requirements of claim 31 (coating semiconductor nanocrystals on a substrate), these limitations are met.

54. Regarding the limitations of claim 32, wherein the applicant requires a p-n junction comprising a plurality of the particles of claim 1. This limitation is met as

set forth above for claim 1, as the examiner interprets the p-type ZnO layer, undoped ZnO layer, and N-type ZnO layer as shown in figure 31 to be equivalent to applicants claimed p-n junction.

55. Claims 6, 17-18, 25-26, and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Alivisatos et al. as applied to claims 1 and 10 above, and further in view of Bhargava et al. (US6241819).

56. Alivisatos et al. does not teach a colloid as required by claim 6.

57. However, Bhargava et al. teaches a method for making a polymer film containing quantum sized semiconductor particles dispersed within the polymer. This method comprises dissolving a metal halide into a solvent that contains polyethylene oxide (PEO), where after the solution is cast into a film and the film is placed in a hydrocarbon solvent that contains a component which reacts with the metal halide to form particles dispersed in the polymer matrix (column 2, lines 18-33). The PEO prevents the particles from clumping together, thereby maintaining their quantum effects. Suitable semiconductor nanoparticles include CdS, and CdSe that have been doped with an activator (column 4, lines 35-45). These particles emit light significantly faster than the corresponding bulk materials and can be used in next generation TV's and displays (column 1, lines 63-67, column 2, lines 40-50)

58. Therefore it would have been obvious to one with ordinary skill in the art at the time the invention was made to disperse the doped semiconductor particles taught by Alivisatos et al. in PEO as taught by Bhargava et al.

59. One would have been motivated to make this modification due to the teaching in Bhargava et al. that semiconductor nanoparticles such as CdS or CdSe dispersed in PEO emit light significantly faster than the corresponding bulk material and can be use in next generation TV's and displays. One would have further been motivated because Alivisatos et al. and Bhargava et al. use the same semiconductors (CdS or CdSe nanocrystals) for the same purpose (displays).

60. It is the examiners position that the limitations of claim 6 are met when the particles dispersed in PEO as taught by Bhargava et al. are used as the electron transport layer in Alivisatos. "Colloid" is defined by Webster's Dictionary 10th edition 1998 as "a substance which consists of small particles dispersed throughout another substance which are too small for resolution an ordinary light microscope but are incapable of passing through a semi permeable membrane." It is the examiners position that the nanoparticles dispersed in a PEO matrix meets this definition. Thus, the limitations of claim 6 are met.

61. Regarding the limitations of claims 17 and 18, wherein the applicant requires a method for making a colloid comprising making a plurality of the particles according to claim 10 (claim 17), and a method for making a film by applying the colloid of claim 17 to a surface (claim 18). Alivisatos et al. teaches all of the limitations of claim 10, upon which claims 17 and 18 are dependent. With respect to the limitations of claim 17, Bhargava et al. teaches a method for forming semiconductor nanoparticles dispersed in a PEO matrix, comprising forming a solution containing a metal salt and a PEO precursor, polymerizing the

PEO precursor, and forming the semiconductor particles within the PEO matrix (column 2, lines 17-35). As stated above for claim 6, it is the examiners position that semiconductor nanoparticles dispersed in PEO meets the definition of a colloid. Although neither Bhargava et al. nor Alivisatos et al. teaches applying this colloid to a substrate in order to form a film, as required by claim 18, it would have been obvious to one of ordinary skill in the art at the time the invention was made to do so, as both Alivisatos et al. and Bhargava et al. are concerned with utilizing semiconductor nanoparticles (dispersed in a matrix or not) as thin films for electroluminescent displays (see column 1 line 67 of Bhargava et al. and the)hole document of Alivisatos et al.). Thus, the limitations of claims 17 and 18 are met.

62. Regarding the limitations of claims 25 and 26, wherein the applicant requires a product produced by the method of claim 17 and 18 respectively. As the applicant presents no further limitations regarding the product, these limitations are met as set forth above for claims 17 and 18.

63. Regarding the limitations of claim 33, wherein the applicant requires the n-p junction of claim 32, further comprising a polymer electrolyte. Alivisatos et al. teaches the requirements of claim 32 as stated above. Although not specifically stated as such, the PEO matrix taught by Bhargava et al. matches the material specified on page 16 of the instant specification as a suitable polymer electrolyte. Thus, the examiner takes the position that the limitations of claim 33 are met when the particles of Alivisatos et al. are dispersed in PEO as in the combination stated above for claim 6.

64. Claims 8, 19, and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Alivisatos et al. as applied to claims 10 and 18 above, and further in view of Bawendi et al. (US6207229) and Bawendi et al. (Journal of the American Chemical Society, Vol 115, #19, 1993, pp. 8706-8715)

65. For the purpose of avoiding confusion, the Journal of the American Chemical Society reference will be referred to as "Bawendi ACS."

66. Alivisatos et al. does not teach capping groups on the surface of the semiconductor nanocrystal, as required by claim 8. Further, Alivisatos et al. does not teach capping groups on the surface of semiconductor nanocrystals, or their use in a method of making semiconductor nanocrystals, as required by claim 19. Last, Alivisatos et al. does not teach using trioctylphisphine oxide (TOPO) as a Capping group on the surface of semiconductor nanocrystals, as required by claim 37.

67. However, with respect to claims 19 and 37, Bawendi et al. teaches that it is know in the art of semiconductor nanocrystals to cap the surface of nanocrystals with an organic passivating agent in order to eliminate forbidden energy levels and improve their photoluminescent yield. In particular, Bawendi et al. teaches that this is known for systems such as CdSe nanocrystals capped with TOPO (column 1, lines 45-58).

68. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to use TOPO as a capping group as taught by Bawendi et al. on the semiconductor nanocrystals taught by Alivisatos et al.

69. One would have been motivated to make this modification due to the teaching in Bawendi et al. that capping semiconductor nanocrystals with an organic moiety such as TOPO is known to increase their photoluminescent yield.

70. Further, with respect to claim 19, Bawendi ACS teaches a method for making semiconductor nanoparticles capped with TOPO (p8707, left column).

71. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the method taught by Bawendi ACS to cap the particles taught by Alivisatos et al. with TOPO.

72. One would have been motivated to do so due to the teaching in Bawendi et al. that capping semiconductor nanoparticles with TOPO increases their photoluminescent yield, and the fact that the process of Bawendi ACS is known to result in semiconductor nanocrystals that are capped with TOPO. One would have been further motivated due to the fact that the material used in Bawendi et al. and Bawendi ACS as the semiconductor nanocrystal matches one of the materials utilized by Alivisatos et al. as the semiconductor nanocrystal.

73. Claim 30 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawasaki et al. as applied to claims 1 and 10 above, and further in view of Bhargava et al. (US5446286).

74. For the purpose of eliminating confusion, this Bhargava reference will be referred to as "Bhargava 286."

75. Alivisatos et al. does not teach an memory array that is comprises a plurality of the particles of claim 1, as required by claim 30.

76. However, Bhargava 286 teaches that semiconductor nanocrystals such as ZnO, CdS, and CdSe, when coated with a ferroelectric material, can be utilized as a non-volatile memory (column 4, lines 62-68, column13, lines 25-45).

77. Therefore it would have been obvious to one of ordinary skill in the art to utilize a ferroelectric coating as taught by Bhargava 286 on the p or n-doped ZnO nanocrystals taught by Kawasaki et al.

78. One would have been motivated to make such a modification due to the teaching in Bhargava 286 that coating semiconductor nanocrystals such as ZnO with a ferroelectric material results in a material that is suitable for use a non-volatile memory.

Allowable Subject Matter

79. Claims 39 and 41-42 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

80. The following is a statement of reasons for the indication of allowable subject matter: The closest prior art is Alivisatos et al. and Kawasaki et al. However, there is no teaching or motivation in the prior art to utilize sodium biphenyl as a reducing agent in a method for forming carrier doped semiconductor nanocrystals, as required by claims 39 and 42. Further, there is no teaching or motivation in the prior art to utilize sodium (Na) as a reducing agent in a method for making n-type semiconductor nanocrystals, as required by claim 41.

R sponse to Arguments

81. Applicant's arguments with respect to claims 1-33 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

82. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Peng et al. Journal of the American Chemical Society, 1997 Vol. 119, pp. 7019-7029. This reference describes a core/shell CdSe/CdS system wherein holes are confined to the core and electrons are delocalized. This reference is very similar to applicants described but not claimed core shell sytem which is presented on pages 8 and 9 of the instant specification.

83. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nikolas J. Uhlir whose telephone number is 703-305-0179. The examiner can normally be reached on Mon-Fri 7:30 am - 5 pm.

84. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Paul Thibodeau can be reached on 703-308-2367. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

85. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-305-0389.

nju
December 27, 2002

Paul Thibodeau
Supervisory Patent Examiner
Technology Center 1700